

ROCKING ARMATURE DRIVE, IN PARTICULAR FOR ELECTRIC SHAVERS

As a drive for electric shavers, among other things rocking armature drives of the most various designs are known. One of the known designs, for which the object of the invention is to improve it, is essentially shown in the drawing in Fig. 1: The drive comprises an electromagnet 1 and an armature 2, rocking back and forth transversely in front of its pole end faces, which armature is secured on a crossbar 3 and is braced by means of it rock ably on two spiral springs 4, for instance leaf springs, that engage different points of the longitudinal axis of the armature, specifically in an arrangement such that the armature 2, in its position of repose, shown, is located laterally offset from the pole end face of the magnet 1, and in operation it is pulled periodically centrally to in front of the pole end face of the magnet 1 by the periodic attraction force of the magnet 1. The rocking motion direction of the armature is indicated by the double arrow 20. The presence and embodiment of the crossbar 3 is intrinsically irrelevant to the mode of operation of the rocking armature drive, and thus the armature 2 could for instance also be secured directly to the top end of the spiral springs 4.

There are also rocking armature drives of another design in which the armature rocks back and forth not transversely in front of the pole end faces but rather vertical to the pole end faces. The first design, shown in Fig. 1, however, has the advantage that the air gap between the magnet and the armature can be markedly smaller, and thus the efficiency can be better.

If each of the two spiral springs 4 in Fig. 1 are imagined as a rigid lever, which is rotatably supported both at the bottom end 41 and at the top end 42, then in operation of the drive shown, the top end 42 of each spiral spring is located not on a straight line in the desired rocking motion direction of the armature 2 but rather on a circular arc, whose center point is located at the bottom end 41 and extends outward from the top end 42. Even if the spiral springs 4 are fixedly fastened to the bottom and top ends, as is shown in Fig. 1, the top end 42 of each spiral spring moves downward along a curve. In each case, the consequence is that the armature 2 also descends along a curve every time it swings inward. Since in that case both ends of the armature descend on the same curve and to the same extent at all times, the armature, at every instant during its rocking motion, does remain parallel to its position of repose, and thus, despite the curved motion of the armature, its longitudinal axis experiences no rotary motion whatever, but only a parallel displacement; however, upon this parallel displacement, upon each inward swing it comes closer to the pole end faces of the magnet. Thus the air gap between the magnet and the armature must be dimensioned as large enough that the armature, in the curved inward swing,

does not strike the pole end faces of the magnet.

If in the arrangement of Fig. 1 one of the two spiral springs were to be left out, and thus the armature were braced on only a single spiral spring, which could for instance also hold the armature in its longitudinal center, then, on the condition of a rigid connection of the armature to the top end of the spiral spring, the longitudinal axis of the armature upon every inward swing would experience not only the aforementioned parallel displacement transversely to its longitudinal axis but also a rotary motion. In a known shaver, in which a blade is braced rockably on a single leaf spring in such a way, the leaf spring is embodied in such a way that it has a constantly varying flexibility along its longitudinal axis, with the least flexibility close to the fastening point and the greatest flexibility at the top end of the leaf spring. Upon sagging, such a leaf spring assumes a different bending shape from that of a normal leaf spring, which has the same flexibility over its entire length, and on the inward swing its top end experiences a lesser rotary motion than the top end of a normal leaf spring; however, a rotary motion of the top end of the leaf spring, and of the blade secured to the top end, is not entirely avoided in this case, either. A more detailed discussion of this known embodiment of the leaf spring of a rocking armature drive and the aforementioned rotary motion is unnecessary, since the following remarks again address solely the situation in which the armature of a rocking armature drive is braced on spiral springs, such as leaf springs, that engage different points of the longitudinal axis of the armature, and thus only a parallel displacement of the longitudinal axis of the armature takes place, but no rotary motion.

However, the inventor has found still another factor that stands in the way of reducing the air gap between the magnet and armature in the type of rocking armature drive shown in Fig. 1, and this factor can occur particularly in such small embodiments of a rocking armature drive of the kind required in electric shavers. The discovery is based on the thought that not only an attraction force in the direction parallel to the pole end faces of the magnet but also an attraction force in the direction of the pole axis or axes of the magnet act on the armature. For the sake of simplicity, in reliance on Fig. 1 of the drawings, the first attraction force will be called the horizontal attraction force and the other will be called the vertical attraction force. The inventor has discovered that the vertical attraction force, which is considerably greater than the horizontal attraction force, in small rocking armature drives in which the spiral springs that brace the armature are comparatively weak, causes a previously unnoticed buckling of the spiral springs, which causes a shortening of the lever length between the top and bottom ends of each of the

spiral springs and thus also causes the armature to approach closer to the pole end faces of the magnet upon each inward swing. The approach of the armature to the pole end faces is thus in that case even greater than with spiral springs that do not buckle. This phenomenon is slight, yet nevertheless significant for the dimensioning of the air gap. Without being aware of it, this phenomenon has already been taken into account before by making the air gap large enough that the armature does not strike the magnet; necessarily, however, this resulted in a larger air gap dimension than is attainable with knowledge of the present invention. In tests of rocking armature drives in which the rocking stroke of the armature in the horizontal direction was on the order of magnitude of approximately 3 mm, a rocking stroke of the armature in the vertical direction of approximately 0.3 mm was found, or in other words on an order of magnitude that on its own cannot be explained by the circular arc shape of the rocking motion.

It is the object of the invention to modify a rocking armature drive of the type shown in Fig. 1 in such a way that despite the circular-arclike motion of the armature and despite the possibility, which also exists, that the spiral springs will collapse, a smaller dimension of the air gap between the magnet and armature is made possible than was attained until now in the known devices. Accordingly, the invention relates to a rocking armature drive, in particular for electric shavers, having an electromagnet and an armature rocking back and forth transversely in front of the pole end faces of the electromagnet, which armature is braced in rockable fashion on two spiral springs, such as leaf springs, engaging different points of the longitudinal axis of the armature, in such a way that the armature in its position of repose is located offset laterally from the pole end face of the magnet and in operation is pulled periodically centrally in front of the pole end face of the magnet by the periodic attraction force of the magnet. According to the invention, a rocking armature drive of this kind is characterized in that the bottom ends of the spiral springs are laterally offset relative to the top ends in the same direction in which the armature is pulled by the magnet in operation.

Two simple exemplary embodiments for embodying a rocking armature drive of this kind are shown in Figs. 2 and 3, in conjunction with which the invention will be described in further detail. Individual parts corresponding to one another in the drawings are each identified by the same reference numerals.

In Fig. 2, the spiral springs 4 as in Fig. 1 have a rectilinear shape in the relaxed state; however, they are disposed at an angle of other than 90° relative to the rocking motion direction

20. In this type as well, the pivoting motion of the spiral springs causes a circular-arclike motion of the top end 42, and buckling of the spiral springs can occur in this type as well. However, the offset disposition of the bottom ends 41 compared to Fig. 1 has the consequence that the top end 42 of the spiral springs, on swinging inward along a circular-arclike path, no longer descends, but rises. Thus while in the known design of Fig. 1, the effects of the two aforementioned phenomena are added together, in Fig. 2 they are contrary to one another, and with a favorable adaptation to one another they even cancel one another out.

The favorable adaptation of the slanting angle of the spiral springs can easily be ascertained. For instance, if with spiral springs of a certain spring strength, in an arrangement of Fig. 1, a horizontal stroke of the armature of 3 mm and a vertical stroke of 0.3 mm was found in the test result reported above, all that is needed is to select the tangent of the slanting angle of the spiral springs, that is, the ratio of the distances a and b shown in Fig. 2 to one another, in such a way that $a:b = 3:0.3 = 10:1$.

In the exemplary embodiment of Fig. 3, the bottom ends 41 of the spiral springs are provided in laterally offset fashion in the same way as in Fig. 2, but here the spiral springs are embodied not as rectilinear but rather as slightly S-shaped and are disposed such that their ends are at an angle of 90° to the rocking motion direction 20. While the embodiment of Fig. 2 has the advantage of rectilinear spiral springs, according to Fig. 3 the advantage of the identical embodiment of the crossbar on both of its ends is obtained, along with the identical embodiment, under some circumstances, of the spiral spring fastening means located at the bottom end.

The magnet 1 and the armature 2 in the subject of the invention can have an intrinsically arbitrary shape and design. For example, the pole end faces of the magnet can be chamfered entirely or in part in a known fashion, and the same is true for the pole end faces of the armature. Instead of the U shape visible in the drawings, the armature can also have the form of a rectilinear block. The spiral springs can also be different from what is shown; for instance, the two spiral springs visible in the drawing could be the legs of an approximately U-shaped leaf spring to the centerpiece of which the armature is secured, as is known per se, as long as only the bottom ends of the two legs of the U are offset according to the invention relative to the top ends. Instead of leaf springs, wire springs or wire spring assemblies could for instance serve as the spiral springs. Each of the two spiral springs can also be replaced by a plurality of individual spiral springs disposed parallel to one another which together act like a single spiral spring.

CLAIMS:

1. A rocking armature drive, in particular for electric shavers, having an electromagnet and
5 an armature rocking back and forth transversely in front of the pole end faces of the
electromagnet, which armature is braced in rockable fashion on two spiral springs, such as leaf
springs, engaging different points of the longitudinal axis of the armature, in such a way that the
armature in its position of repose is located offset laterally from the pole end face of the magnet
and in operation is pulled periodically centrally in front of the pole end face of the magnet by the
10 periodic attraction force of the magnet, characterized in that the bottom ends (41) of the spiral
springs (4) are laterally offset relative to the top ends (42) in the same direction in which the
armature is pulled by the magnet in operation.

2. The drive as defined by claim 1, characterized in that the spiral springs (4) in the relaxed
15 state have a rectilinear shape and are disposed such that they are at an angle deviating from 90°
relative to the rocking motion direction (20).

3. The drive as defined by claim 1, characterized in that the spiral springs in their relaxed
state have a non-rectilinear shape, for instance an S shape, and are disposed such that their ends
20 are at an angle of 90° to the rocking motion direction (20).

References cited: German Patents 666 552 and 843 415

One page of drawings